MORPHOLOGICAL VARIABILITY AND DISTRIBUTION OF STICKLEBACK (*GASTEROSTEUS ACULEATUS* L.) IN SPAIN

by

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ABSTRACT. - Stickleback (*Gasterosteus aculeatus* L.) living in Spain occurs in rivers flowing to the Mediterranean and Cantabrian Seas and to the Atlantic Ocean. Taxonomically studied populations from North-Eastern Spain (La Tordera and Muga rivers drainage basins) belong to low-plated morph (*leiura*) as the rest of all the Spanish populations. According to meristic characters (number of plates, number of rays in dorsal and anal fins, etc.) these populations are similar to other "*leiura*" specimens from Alger, Italy and France, however when comparing these populations with "*trachurus*" specimens from Poland and European Soviet Union, noticable differences appear in body shape : Spanish specimens are characterized by a shorter thorax and first dorsal and ventral spines. Also markedly bigger dorsal, anal and pectoral fins are evident.

RÉSUMÉ. - En Espagne, les épinoches (*Gasterosteus aculeatus* L.) se trouvent dans les rivières s'écoulant vers les mers Méditerranée et Cantabrique, et vers l'Océan Atlantique. Les populations étudiées en taxonomie et provenant du nord-est de l'Espagne (les bassins de drainage des rivières La Tordera et Muga) appartiennent à la forme possédant peu de plaques osseuses (*leiura*) comme toutes les populations d'épinoches d'Espagne. En fonction des caractères méristiques (nombre de plaques, nombre de rayons aux nageoires dorsale et anale, etc.) ces populations sont semblables aux autres spécimens "*leiura*" d'Algérie, d'Italie et de France. Toutefois, lorsque ces populations sont comparées aux formes "*trachurus*" de Pologne ou d'Union Soviétique, des différences notables existent dans la forme du corps : les spécimens espagnols sont caractérisés par un thorax et des épines dorsale et ventrale plus courts, ainsi que par des nageoires ventrale, anale et pectorales nettement plus grandes.

Key-words : Gasterosteidae, *Gasterosteus aculeatus*, Spain, Phenotypic variations, Geographical distribution.

In the ichthyological literature there is no information on the plastic and meristic features of the spanish populations of three-spined stickleback (*Gasterosteus aculeatus* L.). So far only some references on the species ocurrence are available which were summarized by Lozano-Rey (1935). Since this year only two new records have been published corresponding to the Balearic Islands (Riera 1980) and Guadalquivir river marshlands (Hernando 1978). However, and in spite of this historical dearth of information, some authors have made tentative zoogeographical considerations on this species including the iberian peninsula (i.e. Munzing, 1963 ; Gross, 1977).

On the basis of this lack of information, three main reasons made us to investigate these populations. First, because the natural populations of stickleback

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in Spain have been severely injured to the extreme to be included in the "Spanish Threatened Species Check-List" (ICONA, 1986). Second, because a considerable amount of endemic populations occurs in the Iberian peninsula (Lozano-Rey, 1935) and no study has dealt with this species and, third, because in spite of a large number of taxonomical studies carried out on stickleback (Coad, 1981), the problem of the variability in the number of its lateral plates, marked particularly among other characters, has not been convincingly clarified.

Consequently the goals of this paper can be summarized as to describe the actual distribution of stickleback in Spain, to analyze the taxonomical status of these populations with reference to those inhabiting tributaries of the rivers Muga and La Tordera (mediterranean basin, North-Western Spain), comparing the results with other european populations.

MATERIAL AND METHODS

Data presented for stickleback distribution in Spain is based on the fish collections of the National Museum of Natural Sciences (CSIC, Madrid), the fish collection of the Department of Animal Biology (University of Barcelona) and on several personal records and/or communications.

Populations used for metrical and meristical studies were collected at 3 different sites located in Muga and La Tordera rivers drainage basins. Location of sites, shown in Fig. 1b, are : 1. - Lower course of Cabanes river (tributary of La Tordera river) ; 11 individuals were collected on 12 October 1978 : 2. - Lower course of the LLobregat river (tributary of the Muga river) ; 14 individuals collected on

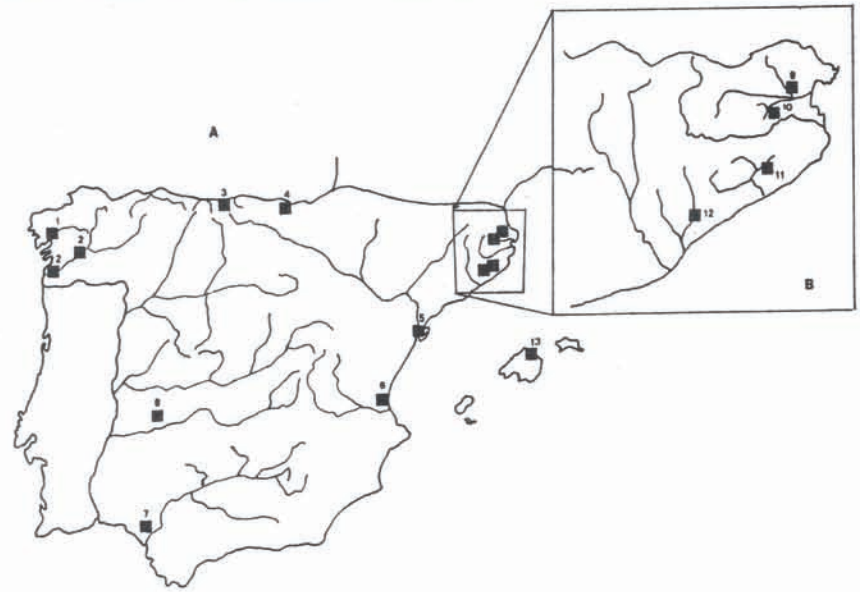

Fig. 1 : Distribution of stickleback (*Gasterosteus aculeatus* L.) in Spain. 1. - River Umia (Galicia), 2. - River Eo (Galicia), 3. - Several records (Santander), 4. - Several records (Pais Vasco), 5. - Delta del Ebro (Tarragona), 6. - Albufera (Valencia), 7. - Guadalquivir river marshlands (Huelva), 8. - River Aljucen (Extremadura), 8. - Records in Catalonia and populations studied taxonomically, 9. - River LLogrebat (Muga river basin, Lérida), 10. - Madral Canal (Muga river basin, Lérida), 11. - River Besos (Barcelona), 12. - River Cabanes (La Tordera river basin, Barcelona), 13. - La Alcudia (Mallorca).

26 october 1980 and 3. - Middle course of the Madral canal (Muga river tributary). 111 individuals were collected on 26 October and 30 November 1980. No more populations could be studied because of scarcity of specimens. However, in all the specimens available their status as "morph" (lateral-plates number) was recorded.

After capture, specimens were fixed in 8-10 % formaline and before examination rinsed 2-3 hours in water. Fin rays and lateral plates were examined and counted with the aid of a binocular microscope. Measurements were made according to Penczak (1962) with an accuracy of 0.1-0.5 mm (depending on the size of a particular organ). Material used for metrical and meristical analysis includes 65 specimens. For the estimation of dorsal spines number and lateral plates we could add 71 additional individuals but these fishes could not be used for any other analysis because they were either damaged or juveniles.

RESULTS

Meristical characters

Material analysed, including our own data are ordered from south to north in Table I. Data on fully-plated stickleback from Belgium, Germany, Poland and the European Soviet Union are used for discussing the species position of North-Eastern Spanish populations.

Sticklebacks collected in both La Tordera and Muga rivers drainage basins belong to the low-plated freshwater morph (*leiura*) and according to the number of plates they occupy a middle position along the south-north distribution of the *lieura* morph in Europe (Table II). Lowest number of plates were recorded in Northern Africa

Table I : Location of sites with materials used for comparative analysis.

Site	Country and river basin (R.)	Latitude (North)	Longitude (East)	Capture date	Author
Maison Carrée	Alger, Smar R.	36° - 43°	3°	1923-24	Bertin, 1925
Cabanes river	Spain, La Tordera R.	41° - 50°	2°50'	1978	own data
Madral river	Spain, Muga R.	42°	2°	1980	own data
Llobregat river	Spain, Muga R.	42°	2°	1980	own data
Peninsola Salentina	Italy, Galeso R.	40° - 41°	14°	1978	Bianco, 1979
Calabria	Italy, Crati, Bifemo and Lesina R.	42°	14°	1975-79	Bianco, 1981
Puy-de-Dome	France, Ambene R.	45°	3°7'	1924	Bertin, 1925
Dieuze	France, Meurthe R.	45° - 49°	6°37'	1923	Bertin, 1925
South Belgium	Belgium, Meuse R.	49° - 51°	4°5'	1945	Heuts, 1947
Yser river	Belgium, Yser R.	50° - 51°	2°50'	1944-45	Heuts, 1947
Oldesloe	Germany, Trave R.	53°50'	10°20'	1956	Münzing, 1959
Krayne	Germany, Odra R.	52°	14°	1969	Paepke, 1970
Poland	Poland, Vistula and Odra R.	50° - 54°	14° - 23°	1955-62	Penczak, 1965
Soviet Union	European region, Baltic, White, Black and Azov Seas.				Potapova, 1967-72

Table II : Frequency of plates in the spanish populations of stickleback (*Gasterosteus aculeatus* L.) studied and in other populations used for comparative purposes, ordered as in Table I.

Site	N	Number of plates											
		0	1	2	3	4	5	6	7	8	9	10	X̄ ± 95 % CL
Maison Carrée	121	6	9	65	33	8							2.2 ± 1.7
Cabanes river	11				4	6	1						3.7 ± 1.3
Mardal river	111			1	9	60	34	7					4.3 ± 1.5
Llobregat river	14				2	9	3						4.1 ± 1.2
P. Salentina	21	1			1	9	8	1			1		4.5 ± 3.1
Calabria	52	-	-	-	-	-	-	-					3.1
Puy-de-Dome	402			5	47	130	188	29	3				4.5 ± 1.7
Dieuze	152				2	17	52	59	16	6			5.6 ± 2.0
South Belgium	466				1	24	131	136	157	17			6.0 ± 2.0
Oldesloe	67			2	4	19	29	12	1				4.7 ± 1.9
Krayne	109						3	18	55	28	5		7.1 ± 1.7
Poland	7							1	1	3	1	1	8.0 ± 2.5

Table III : Frequency of dorsal fin rays in stickleback (*Gasterosteus aculeatus* L.)

Site	N	Number of dorsal fin rays							
		8	9	10	11	12	13	14	X̄ ± 95 % CL
Maison Carrée	60			1	18	35	6		11.8 ± 1.27
Cabanes river	11					10	1		12.1 ± 1.59
Madral river	40				2	22	14	2	12.4 ± 1.31
Llobregat river	14				1	6	7		12.4 ± 1.25
P. Salentina	21				3	12	6		12.1 ± 1.27
Calabria	52			-	-	-	-	-	12.1 ± 1.47
Puy-de-Dome	201		1	7	57	107	28	1	11.8 ± 1.49
Dieuze	70		1	3	27	38	1		11.5 ± 1.14
South Belgium	470		3	31	267	161	8		11.3 ± 1.25
Yser river	529	1	4	49	292	170	14		11.3 ± 1.35
Oldesloe	67	1	1	16	45	4			10.8 ± 1.29
Poland	350		4	73	183	75	14	1	11.1 ± 1.58
Soviet Union	657		-	-	-	-	-	-	11.2 ± 1.66

Table IV : Frequency of anal fin rays in stickleback (*Gasterosteus aculeatus* L.)

Site	N	Number of rays in anal fin						$\overline{X}$ ± 95 % CL
		6	7	8	9	10	11	
Maison Carrée	60			10	27	21	2	9.3 ± 1.51
Cabanes river	11			1	10			8.9 ± 0.59
Mardal river	40				24	15	1	9.4 ± 1.08
Llobregat river	14			1	3	9	1	9.9 ± 1.09
P. Salentina	21			10	10	1		8.6 ± 1.18
Calabria	52			-	-	-		9.1 ± 0.72
Puy-de-Dome	201		6	50	108	35	2	8.9 ± 1.48
Dieuze	76	1	4	29	36	5	1	8.6 ± 1.59
South Belgium	400		69	235	87	9		8.1 ± 1.35
Yser river	530		33	285	191	21		8.4 ± 1.29
Oldesloe	67		2	11	51	3		8.8 ± 1.08
Poland	350	2	52	156	122	18		8.3 ± 1.57
Soviet Union		-	-	-	-	-		8.2 ± 1.36

(introduced population according to Bertin, 1925) and in Calabria (Italy). Going to the north, number of plates in ***leiurus*** increases by twofold (Table II).

The evidence obtained from the present investigations (3 specimens with four dorsal spines against 108 with three spines, i.e. 2,7 %) supports Bertin's suggestion (1925) in the sense that the number of dorsal spines does not depend on water temperature. A similar, or highest, percentage of stickleback with four spines were found in North Africa (5.4 %), in France (2.8 %) (Bertin, 1925) and in Poland (rivers Narew (3.1 %) and Zamosc (5.3 %) (Penczak, 1965).

Number of dorsal fin rays grows slightly from the south but not always proportionnaly (Table III). Modal values from Alger, Spain, Italy and France is 12 rays but in the Northern European populations is only 11 rays, however mean values are in the range of the 95 % CL (Table III). The highest means (> 12 rays) were recorded in Spain and Italy. Rays in anal fin show the same trend of variability (Table IV) but similarity is that one shown in dorsal fin pattern. It means that the observed differences for mean values are in the range of the 95 % CL. Also the modal value for mixed populations (Northern Europe) is lower in one ray less, although small exceptions are observed (Table IV). The number of pectoral fin rays in our sample counts 10 rays. We found only one specimen with 9 rays. The means for number of rays in pectoral fin calculated by Huets (1947) and Penczak (1965) were also very close to 10, therefore it could be considered as a constant character for the species. The caudal fin contains 12 rays. Only two specimens - one from Llobregat river and other one from Madral canal - showed 13 rays. All specimens investigated by Bianco (1979) had 12 rays while Penczak (1965) studying 2122 specimens found only one individual with 11 rays and other one with 10 rays, facts that confirm the stability of this character for stickleback.

Table V : Description of metrical characters of stickleback (*Gasterosteus aculeatus* L.) as percentage of longitudo corporis (mean ± 95 % CL).
* Range for the means obtained for 10 populations.
** Range for the means obtained for 4 populations.

Site	Llobregat R.	Mardal R.	Cabanes R.	Poland	Soviet Union
Characters	N = 14	N = 40	N = 11	N = 10*	N = 4**
Longitudo totalis	117.4 ± 2.5	117.5 ± 2.9	117.4 ± 2.5	112.0 ± 114.8	
Spatium praedorsalis	62.8 ± 3.6	62.3 ± 2.3	61.6 ± 3.6	63.5 ± 67.0	61.4 - 63.8
Spat. praepectoralis	36.2 ± 2.7	37.1 ± 2.8	36.6 ± 2.8	36.8 ± 38.7	
Spat. praeventrale	44.8 ± 3.2	44.9 ± 3.3	44.3 ± 3.6	44.8 ± 47.3	
Spat. praenale	66.0 ± 4.0	66.4 ± 2.9	64.5 ± 5.5	69.5 ± 73.4	68.7- 71.8
Long. cap. lateralis	30.2 ± 2.2	30.3 ± 1.6	30.4 ± 2.6	29.8 ± 31.9	
Long. caudae	14.3 ± 2.3	13.9 ± 2.0	12.7 ± 2.0	11.8 ± 14.8	
Altitudo DI	8.1 ± 1.6	8.0 ± 1.2	8.4 ± 1.4	8.6 ± 10.4	9.3 - 11.5
Altitudo VI	13.2 ± 1.6	12.8 ± 2.0	12.9 ± 2.2	13.4 ± 15.9	13.3 - 14.8
Long. basis D	26.0 ± 1.7	26.6 ± 2.0	27.2 ± 3.1	23.2 ± 25.4	
Altitudo D	13.5 ± 1.3	14.2 ± 2.0	13.7 ± 2.8	10.0 ±12.9	11.7 - 13.3
Long. basis A	19.1 ± 4.4	20.9 ± 2.4	20.6 ± 3.2	16.4 ± 19.0	17.7 - 18.0
Altitudo A	13.1 ± 1.5	13.8 ± 1.5	13.5 ± 1.9	9.4 ± 11.7	10.6 - 11.7
Long. P	16.3 ± 2.0	17.9 ± 1.8	16.7 ±2.6	14.8 ± 16.9	15.7 - 17.1

Plastic characters

The morphometric analysis included 65 sticklebacks (Table V). The following plastic characters have appeared to be rather stable for these populations : spatium praeventrale, longitudo capitis lateralis, altitudo DI and altitudo A. Sticklebacks from these samples differ from each other by much less than the value of 95 % CL (Table V).

A comparison of the body shape of the spanish sticklebacks versus the polish and soviet populations shows some differences which can be summarized as : the spanish sticklebacks exhibit shorter thorax and shorter first dorsal and ventral spines. Their dorsal and anal fins are bigger (longer and higher) and the pectoral one is a longer (Table V).

DISCUSSION

The recorded distribution of stickleback in Spain is shown in Fig. 1. Because of different reasons (pollution, river chanelization, etc.) some of these populations are likely to be extincted, or close to extinction, especially those from the rivers Aljucen (Extremadura) and LLobregat (Catalonia). As it can be seen the stickleback occurs (or has recently occured) in rivers flowing to the three seas surrounding Spain

(Mediterrean and Cantabrian Seas and Atlantic Ocean) and all the populations recorded and investigated by us belong to the low-plated morph (*leiura*). This fact comes to join the evidence pointed out by Bianco (1981) in the sense that all the Mediterranean populations belong to "*leiura*" morph as it was previously noted by Bertin (1925), Maresca (1926) and Tagliani (1926) and recently confirmed by Crivelli and Britton (1987), with the only exception of a "*trachurus*" population cited by Stephanidis (1974) in Greece. In Europe, numbers and largest means were recorded in East Germany (Paepke, 1970) and Poland (Penczak, 1965). Mediterranean "*leiurus*" morphs from Spain and Italy are characterized by similar and higher number of dorsal rays (Table III) and regularity was not recorded for anal fin (Table IV), however from the data chosen by us for comparative purposes, it can be seen that mixed populations are distinguished by lower number of rays in its fin (Table IV). These data do not support Gross'suggestion (1977) of occurrence of an "inflexion point" with minimum soft rays number in dorsal fin for low-plated morph "at approximately 50° N" altitude".

Stickleback body shape employing plastic characters has been investigated by Penczak (1962, 1965) and Potapova (1967, 1972), but these investigations concern "*trachurus*" populations only. In Table V, it is shown that these additional characters are able to distinguished between low-plated and fully-plated sticklebacks. Besides Crivelly and Britton (1987) have found the mediterranean populations to have shorter spines, fact also recorded by Bianco (1981) in Italy and confirmed by our results for Spain (Table V).

In what concerns the zoogeography of this species, Bianco (1981) hypothesis that the colonization of the Mediterranean region by stickleback has occured through rivers, in opposition to those authors who suggest anadromous ancestors migrating through the Atlantic Ocean. We think that this theory satisfactory explains the distribution of stickleback in Northern Spain which is occupied by "*leiurus*" morph populations. Within this region, stickleback does not live in Asturias whose rivers flowing to the Cantabrian Sea are dominated by Salmonidae (namely *Salmo salar* L. and *S. trutta* L.) and the family Cyprinidae is absent (seldom present is ***Phoxinus phoxinus*** supposedly introduced in this century), however stickleback occurs in several rivers flowing to the Cantabrian Sea in Santander and Galicia (eastern and western regions surrounding Asturias) where extensive cyprinid assemblages, together with trout and salmon, co-exist with stickleback in ecologically similar rivers (similar water temperature, oxygen, slope and water speed, bottom structure, etc.). This fact suggests a river colonization because if stickleback would had colonized the north of Spain through marine ways, it would be present in all the rivers of Asturias.

The same author suggests that the populations of stickleback from Sardinia are not autochtonous but they were introduced in the XIX century. According to the fact that both populations known to occur in mediterranean islands (Mallorca and Sardinia) also belong to "*leiura*" morph as it does the population of North-Africa (suspected to be introduced by Bertin (1925) but cited 60 years before by Gervais (1866), two hypothesis can be suggested : 1. - All the populations living outside of the european part of the mediterranean basin have been introduced in historical times (Bianco, 1981) including the population from Mallorca (Balearic islands) or 2. - Stickleback has colonized all the mediterranean region by rivers before or early Miocene with simultaneous (or alternative) colonization Spain-Marroco through, for instance, the "Betico-Rifeño" bridge which connected the southern iberian peninsula with northern Marroco and, later on, extinction of populations together with the movements of the Thetys Sea could have produced residual stocks in Northern Africa and in the mediterranean islands.

Consequently with this hypothesis, two main points could be inferred : 1. - The distributional pattern of stickleback as a result of this way of dispersion and colonization would be similar, for instance, to that of *Cobitis sp.* that occupies all the European Continent and shows some scattered populations in Northern Africa (North-Western Marroco) and 2. - Therefore, the populations of stickleback inhabiting Northern Africa and the mediterranean islands could not have been introduced by human activites but they would belong to the natural distribution area of the species.

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REFERENCES

BERTIN L. , 1925. - Recherches bionomiques, biométriques et systématiques sur les épinoches (Gastérostéides). *Ann. Inst. Oceanogr. Monaco*, 2 : 1-204.

BIANCO P.G., 1979. - Sulla presenza di *Gasterosteus aculeatus* L. nella peninsola salentina (Pisces, Gasterosteidae). *Natura*, 70 (1-2) : 76-80.

BIANCO P.G., 1981. - Areale italico, rinvenimento in Calabria e origine delle popolazioni mediterranee di *Gasterosteus aculeatus* L. (Pisces, Gasterosteidae). *Boll. Mus. Civ. St. Nat. Verona*, 7 : 197-216.

COAD B.W., 1981. - A bibliography of Sticklebacks (Gasterosteidae : Osteichthyes).*Syllogeus. Nat. Mus. Nat. Sciences. Ottawa*, 35 : 1-142.

CRIVELLI A.J. & R.H. BRITTON, 1987. - Life history adaptations of*Gasterosteus aculeatus* in a Mediterranean wetland. *Env. Biol. Fish*, 18 (2) : 109-125.

GERVAIS P., 1866. - Nouvelles remarques sur les poissons fluviatiles de l'Algérie.*C.R. Ac. Sci. Paris* 63 : 1051.

GROSS H.P., 1977. - Adaptative trends on environmentally sensitive traits in the three-spines stickleback, *Gasterosteus aculeatus* L. *Sond. Z. f. Zool. Syst. Evolut.*, 15 (4) : 252-278.

HEUTS M.J., 1947. - The phenotypical variability of *Gasterosteus aculeatus* (L.) populations in Belgium. *Meded. Kon. VI Acad. Wetensch. Belg. Antwerpen*, 9 (25) : 1-63.

HERNANDO J.A., 1978. - Estructura de la comunidad de peces de la Marisma del Guadalquivir. Ph. D. Thesis. University of Sevilla.

ICONA, 1986. - Lista roja de los vertebrados españoles. *Pub. Min. Agr. Pes. y Alim. Secret. Gen. Tec. MAPA*. Madrid.

LOZANO-REY L., 1935. - Los peces fluviales de España. *Mem. R. Acad. Cienc. Exact. Fis. y Nat.*, 5 : 1-390.

MARESCA M., 1926. - Considerazioni sulla bionomia di *Gasterosteus aculeatus* L. del fiume Sarno in Campania. *Arch. Zool. Ital.*, 11 : 199-241.

MUNZING J., 1963. - The evolution of variation and distributional patterns in european populations of the three-spined stickleback, *Gasterosteus aculeatus*. *Evolution*, 33 : 320-332.

PAEPKE H.-J., 1970. - Studien zur öecologie, variabilitat und populationsstruktur des Dreistachligen und Neunstachligen Stichlings. II. Die variabilität der lateralbeschildung von *Gasterosteus aculeatus* L. in einer brandenburgischen intergradationszone und ihre zoogeographischhistorischen hintergründen. *Veröff. Mus. Potsdam.* 16 : 23-34.

PENCZAK T., 1962. - The biometry of the stickleback *Gasterosteus aculeatus* L. from the Ner river. Frag. Faun., 10 (10) : 137-161.

PENCZAK T., 1965. - Morphological variation of the stickleback (*Gasterosteus aculeatus* L.) in Poland. *Zool. Pol.*, 15 (1) : 3-49.

POTAPOVA T.L., 1967. - On the spread of the three-spined stickleback morphs in the waterbodies of the Soviet Union. *Vest. Moskovsk. Univ.*, 1 : 19-27 (In Russian).

POTAPOVA T.L., 1972. - Inter-Species variability of three-spined stickleback *Gasterosteus acuelatus* L. *J. Ictiol.* 12 : 25-40 (In Russian).

RIERA F., 1980. - Breves notas y primera cita del Espinoso (*Gasterosteus aculeatus* L.) en S' albufera, Mallorca. *Boll. Soc. Hist. Nat. Balears*, 24 : 109-111.

STEPHANIDIS A., 1974. - On some fish of the Ioniokorinthian region (W. Greece ect.) - A new genus of Cyprinidae : *Tropidophoxinellus* n. gen. *Biol. Gallo-Hellenica*, 5(2) : 235-257.

TAGLIANI G., 1926. - Sulla variabilita di alcuni caratteri quantitavi di *Gasterosteus aculeatus* L. del fiume Sarno (Campania) con una esposizione riassuntiva del principali processi aritmetic statistica, biometrici. *Arch. Zool. Ital*, 11 : 243-358.

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